

## The ILLINOIS ENGINEER

ILLINOIS SOCIETY OF PROFESSIONAL ENGINEERS  
INCORPORATED

Affiliated with the National Society of Professional Engineers  
614 East Green Street Champaign, Illinois



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SUMMER ISSUE

AUGUST, 1957

## PRESIDENT'S MESSAGE

by ANDREW W. NEUREUTHER, President

NSPE-ISPE now has a great opportunity and challenge in the form of a proposal recently announced by the American Institute of Electrical Engineers.

Each opportunity comes but once. Yet many opportunities seem to come to those who are always ready for opportunity. A still greater organization can arise from an organization which recognizes and utilizes its opportunities.

AIEE has generously offered the suggestion that NSPE handle all professional matters such as registration, employment practices, salaries and fees, legislation, and ethics for AIEE. It has recommended to the other Founder Societies that they do likewise.



President Neureuther

Here will be a beneficial, mutually cooperative arrangement for all engineers. In a changing world this will be a change for the better. It will be an improvement long sought in the engineering profession. It will be another major step toward the unification of the engineering profession.

AIEE has been considering this move for ten years. Meanwhile it has referred the idea to other societies who have not yet come forward positively as AIEE has done.

It will take a lot of broad and progressive thought and action on the part of NSPE to modify its policies, to gain the greatest stature, and to achieve the greatest mutual good with AIEE. It can be done.

Successful completion of this first step should lead to a rapid succession of more steps to further consolidate the engineering profession. After all, many engineers belong to both AIEE and NSPE right now.

We all have a job to do to handle our share of the matter in ISPE for the engineers of Illinois. The other state societies must do likewise in their respective areas.

Each ISPE member is certain to be a part of this, and to be affected by it eventually. He may be asked his opinion from time to time; and is certain to be asked to vote on the constitutional amendments necessary.

Consequently every member should familiarize himself with the AIEE proposal and be ready to take his

part in the action on it. THE AMERICAN ENGINEER for July 1957, on pages 28 and 29, has published it. Comprehensive editorial comment appears in the ELECTRICAL WORLD, July 15, 1957, page 57; and in ENGINEERING NEWS RECORD, July 18, 1957, pages 23 and 24.

Intersociety action will require the finest team work. Let's be ready to "carry the ball" when it is handed to us.

## VOX SECRETARI

By P. E. ROBERTS, Executive Secretary

### Continental Casualty Company

The Continental Casualty Company Sickness and Accident Insurance Plan is slowly, but surely, catching on. Not only is the insurance protection the finest which can be obtained, but also, the group plan makes it possible to offer this protection at the lowest possible cost. In other words, you are buying a quality protection at an extremely reasonable price. Representatives from Harris Associates will call upon you to explain the plan in detail; however, if you are desirous of immediate information, please address Mr. Jerry Harris at Harris Associates, 105 West Madison Street, Chicago 2. See the insurance advertising page.

Along the same subject, a brochure has been prepared together with a letter signed by President Neureuther which will go to registered professional engineers in Illinois who are not now members of the Society, inviting them to become members. This is a splendid example of two groups, that is, an engineering society and insurance associates working together for the mutual benefit of each. Any member of the Society who reads this un-

I hold every man a debtor to his profession;  
from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereunto.

Sir Francis Bacon

### SUBSCRIPTION RATES

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doubtedly knows several registered engineers who are not members of the Society. You can help by urging this non-member to send in the inquiry card for further information.

### Structural Examination Questions

The third set of examination questions will be found on other pages of this issue and the fourth set will appear in the September issue. These four sets plus the questions published in previous ILLINOIS ENGINEERS have been combined to make up the first edition of the Structural Examination Questions Book. The new book will be the third examination question book published by the Society, the other two, of course, being professional and land surveyor. The new book will be ready for distribution on September 3. A coupon for ordering is given below.

### Refresher Course Classes

Within two weeks the set of refresher course classes in preparation for the Fall examination will begin. Professional classes have already been scheduled for Chicago, LaGrange and Joliet. Undoubtedly more will be organized, as the average number of classes during the past few years has been eight. A structural class is planned to meet at Rockford. No land surveyor classes have been scheduled so far. Examination dates are as follows:

Structural—December 18, 19 and 20

Professional—November 21 and 22

Land Surveyor—November 4, 5 and 6

### Workshop Conference

The first Illinois Society Workshop Conference held last Fall was so successful that it will be repeated again this year with added features. The conference, which appears very much like it will become an annual event, will be held at Robert Allerton Park on September 13 and 14. Committee Chairmen will be invited to attend conferences which will be held on Friday afternoon and Saturday morning. At least one functional section—Engineers in Industry—is planning to hold a meeting either on Friday afternoon or Saturday morning. The Board of Direction meets on Saturday morning and everyone attending the conference eats lunch Saturday noon.

### Constitutional Amendments Ballot

The July issue of the ILLINOIS ENGINEER contained a Constitutional Amendments ballot. If you have not already voted, you will have just time enough to mark your ballot and mail it after you receive this issue. Polls close on August 20, therefore, it is imperative that you mail your marked, signed ballot the same day you receive this issue.

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# How Do We Solve the Engineering Manpower Problem for the Highway Program?

By V. J. BROWN, *Vice President*

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The highway engineering manpower problem can be solved by no single, swift, bold stroke. Many administrative, management, equipment, and personnel changes are necessary. They are so necessary that highway administrators—federal, state, and county—must analyze and delve into the problem promptly. Most all highway administrators are willing to admit that to some extent, their departments are still operating in accordance with procedures and practices, technical and political, established over the years. In various states and counties unnecessary surveying, use of inefficient methods, tedious plotting and replotting of cross sections, and endless calculations to the third decimal are (in some cases, were) collectively thieving engineering time. There should be no "sacred cows" in highway administration. Too often the attitude that "we've always done it this way", or the political control rather than efficient administrative control, stands in the way of progress. Also, the rather general human characteristic of willingness of administrators to leave things as they are and live with a situation which is admittedly tough to change, is a major obstacle to more effective administration.

Because of the demands of the 1956 Federal-aid Highway Act it is mandatory that administrators plan, stimulate, and develop improvements in methods and techniques, and keep abreast of the latest thoughts and practices. Although many technical improvements, new equipment employment, and organizational arrangement can be brought about to improve administrative efficiency, maximum results cannot be achieved without competent and loyal personnel. The fact that highway departments are still having considerable difficulty in obtaining and retaining competent personnel indicates that they are not offering an attractive package to prospective engineers and technical people.

## Salaries and Fringe Benefits

Mr. Harold L. Plummer, Chairman, Wisconsin State Highway Commission, has said the following about salaries:

"Salary alone is not enough to attract personnel these days, although salaries dare not be much below the going rate. Many factors influence a graduate engineer's choice, some of which oftentimes outweigh salary considerations. Our experience indicates that the graduate is more concerned with advancement opportunities than with any other single factor. Promotion, salary, training, and location ranked in that order of importance.

More liberal and enlightened promotional policies will be required."

He also said: "In contract and project supervision, manpower can be saved and utilized more effectively if contracts are let and contractors start working as early in the year as possible. An analysis of projects completed in the 1956 season in one district disclosed that about 80 per cent of them could be completed within the normal construction season. It is important to keep the contractor on schedule. Each delinquent operation puts an added strain on limited supervisory personnel, upsets any plan for orderly administration. We are revising contract procedures and are providing lump sum bids, package deals, and elimination of some final measurements."

Other new administrative tools and new methods are being employed such as radio telephone, new drafting and reproduction methods, plan preparation by photography and printing on tracing cloth, standardization of bridge designs, standardization of materials gradations, prestressed and precast concrete, positioning of reinforcing bars, photogrammetry, electronic computer, the use of consulting engineers, and the development of technicians.

## Radio Telephone

Mr. H. A. Radzikowski, Chief, Maintenance Branch, U. S. Bureau of Public Roads, states, "County and local highway departments are already taking advantage of one of the most effective methods of conserving manpower and engineering on road maintenance and betterment and of decreasing the volume of paper work through better communications. There are now 246 county and local highway departments using radio telephones in the management of mechanized maintenance and construction operations and the number is growing rapidly."

States and counties should study the possibilities of cooperative setups for this effective tool.

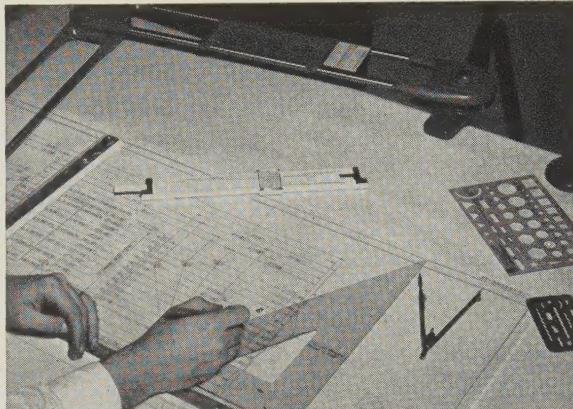
## New Drafting and Reproduction Methods

In Texas plans are being successfully reproduced from penciled tracings on paper. More permanent sets of plans are reproduced from the penciled plans by photographing and printing on linen tracing cloth. These and other improved methods decreased by three months the time required to prepare 260 sheets for a five-mile federal-aid project with numerous structures. The Texas Highway Department estimates a saving of 40 percent in technical man-hours for ordinary plan preparation and 60 percent reduction in engineering cost on this item.

\*Paper delivered before 31st Annual Highway Short Course, University of Illinois, Feb. 27, 1957.

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### Bridge Design Standardization

Considerable progress has been made in the use of precast reinforced and prestressed concrete bridges in Mississippi, Tennessee, Louisiana, Illinois, and other states. If standardization of precast reinforced concrete bridge members could be accomplished among all of the states, it would permit manufacturers to stockpile such bridge units ready for delivery. In Georgia a commercial form in which the positioning of the reinforcement bars is already arranged for cast-in-place concrete bridges has produced good results. Construction time is reduced to few days and a minimum of engineering is required. With respect to the longer spans, adoption of uniform standards for prestressed concrete beams would encourage their development commercially and save substantially on engineering and field construction time for a bridge crossing over steel because of the long lead time now required for delivery of bridge steel. Standardization of design for bridges, culverts, headwalls and inlets, and of materials gradations is a further means of conserving construction engineering.

### Photogrammetry

During the past 10 years the application of aerial photogrammetry to highway engineering has advanced from the experimental stage to a proven technique that not only increases the quantity of work produced but also improves the quality of highway plans. In your program there are two separate sessions on mechanical aids; one deals with photogrammetry, the other with electronic computers. Consequently I shall limit my remarks on these mechanical aids.

In reconnaissance of an area to determine the general land location, all available aerial photography and maps are used. In many instances photography that can be viewed stereoscopically is available from the Agricultural Marketing and Production Administration. Contour maps made by the U. S. Geological Survey are also used to good advantage. Where photography is not available, new photography is flown at a high altitude to provide stereo photos at a scale of 1,600 ft. to the inch.

With these maps and pictures a wide area is studied and all possible road locations are given consideration. However, usually control points must be met and the most feasible general location is determined at this stage.

### Kelsh Plotter

Concurrently with plotting the maps the necessary information for cross sections is taken from the stereo plotting instrument called the Kelsh Plotter. The cross section data may be written into a field book or it may be transmitted electrically to a key punch machine that will punch a card and print the data at the same time. The electrical transmission is used if an electronic computer is to be used for earthwork quantity calculations. Not only will the Kelsh Plotter read elevations to 0.1 of a foot, but Ohio has now developed an attachment to the foot of the plotter that will automatically register the horizontal distance within an accuracy of

0.1 of a foot. Thus all cross-section data are automatically recorded and registered on punch cards to be fed into the electronic computer. The key instrument between the aerial camera and the computer is the Kelsh Plotter.

### Digital Computer

The electronic computer is a most valuable instrument for saving engineering time. It calculates with such rapidity, once a program has been established, that one thinks it a magical machine. Punch cards are fed into it and answers are printed, even to the location of and readings to be put on slope stakes.

Photogrammetry coordinated with the digital computer is also used to calculate final quantities on a construction project. This full use of automation has been claimed to reduce engineering manpower requirements over 70 percent. It has been demonstrated that the electronic computer can compute earthwork quantities 30 times as fast as can be accomplished manually. Another test proved that 10 minutes of an electronic computer's time is equivalent to one week of a bridge designer's time engaged in moment and stress computations. Besides this, more efficient engineering results because various comparisons can be made quickly.

It is important to note that the Bureau of Public Roads recognizes rental of electronic computer time, tied into the engineering for specific federal-aid projects, as reimbursable with federal funds as engineering on the federal-aid systems on a 50-50 basis.

### Lump Sum Bid

Engineering manpower may be conserved also in the form of contract letting. The lump-sum bid lends itself to such classes of highway work as clearing and grubbing, light grading, and the fabrication and erection of structural steel, culverts, and bridges above the footings. Where applicable the payment for earth work on the basis of plan quantities will also decrease engineering requirements. In parallel with this procedure are the short-cut engineering methods used in Iowa and Kentucky for county contract grading jobs.

It would not be heretic to mention here that considerable construction time can be saved, and thus engineering time, by specifying results rather than methods or procedures for contractors. This will allow the contractor to use his ingenuity and aid in manpower problems.

### Consulting Engineers

Resort may be taken as an assist by the use of consulting engineering firms. There have been some criticisms of these firms in the past for proselyting personnel of the state highway department, but I understand that proposed provisions for future consulting contracts will prevent this.

### College Student Recruitment

One of the big stumbling blocks to recruitment of high school graduates for engineering college work is the extremely high cost of an engineering education. Young men know this and they also learn that salaries and fringe benefits in highway engineering are smaller than

can be obtained in other branches. A report in the Journal of the National Education Association states that of those not planning to seek higher education, three out of four would go to college if adequate scholarship help was available.

The shortage predicted is predicated upon demands of past requirements. Besides this, new categories of engineering requirements are opening such as, nuclear energy, electronics, automation, and others. As I see the problem, under the supervision of engineers technicians can take over work now being done by engineers. Frequently, in administration, design, construction, maintenance, and operation, too great an emphasis is placed on a college degree. Sometimes, without justification, such degrees serve only as a sort of screening device for abilities, and accordingly it does not follow that the use of college graduates in all types of technical work is the best utilization of manpower.

### Conclusion

Progress can be made in solving the shortage of engineering manpower partially by machines and procedures discussed heretofore, but more importantly by redefining job requirements and better use of available engineering talent. Re-evaluation of job requirements may indicate that many tasks now performed by college graduates could be carried out satisfactorily by men or women who, for one reason or another, have not gone

to college or who have not completed a college course. Trained technicians can do certain jobs as well as graduate engineers. This, however, is not to say that highway departments should relax their high standards for those positions in which college training or the equivalent has been shown to be essential.

Following the above thesis, an entire new technician area of employment becomes apparent. I believe that the need in this area should not be met by expanding vocational or trade schools, but rather by new patterns of education for screened applicants. The engineering technician belongs to a relatively new group of specialists who work with professional engineers and scientists. He is an important and essential member of an engineering team in research, planning, designing, construction, and maintaining the highway plant. He should be familiar with the work of the other members of the team, who are normally the professional engineers or technicians with long experience.

As an engineering aide, the functions of the technicians may be similar to those of the engineer, but differ in level of complexity, the completeness of instructions, and the amount of supervision. Among his activities he may engage in such work as drafting, surveying, testing, inspecting, detail designing, cost estimating, computing, expediting, report writing, statistics and many other sub-professional activities. With experience he will rise to many supervisory-level activities.

## EXAMINATION QUESTION BOOKS

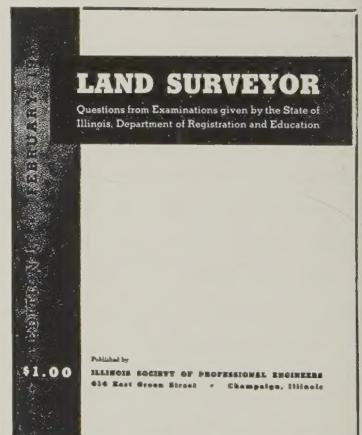


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# Typical Structural Examination Questions

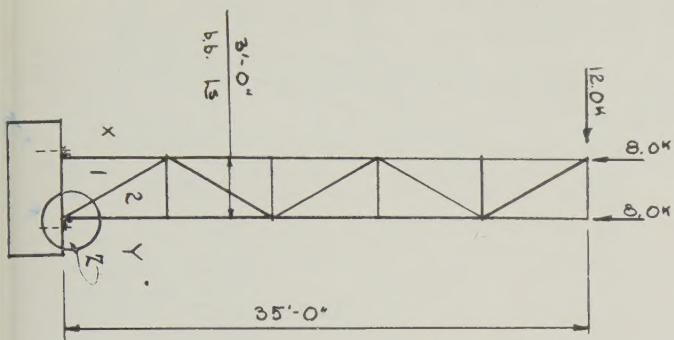


Fig. C-11

C11. A steel tower is 3'-0" square back to back of angles. The tower carries a horizontal load of 12,000# at the top, and a vertical load of 4000# on each leg. Neglect wind and dead load of tower. Draw a stress diagram and design members 1-x, 1-2 and 2-y. Detail the anchorage connection at Z. (See Fig. C11).

C12. Determine the maximum bending moments at the haunch and crown in Fig. C12. Give the vertical and horizontal reactions at the base.

C13. The exterior columns of a building support a canopy beam acting as a cantilever in Fig. C13. Design the beam A, column B, and detail the cantilever connection Z.

C14. Neglecting dead load of girder, design a craneway plate girder with a 75 foot span with two moving loads spaced 12 feet apart, one load being 70,000 lbs. and the other 50,000 lbs. Proportion girder by net section method deducting holes on tension side only. Assume top flange braced laterally.

C15. Two beams 36 WF 230 at right angles to each other, crossing at mid span, support a load, jointly, of 160,000 lbs. One beam has a span of 30 feet and the other of 20 feet. Calculate unit stress in each beam and deflection at the load. Neglect weight of beams.

C16. Fig. C16. Design a web splice of the type indicated for maximum shear and maximum moment resulting from the specified load. Detail splice to show rivets required for maximum shear and maximum moment.

C17. Fig. 17. Indicates a tower span of elevated railway type. Calculate the stress in the column that will result from a change in temperature of  $\pm 70^{\circ}$  F.

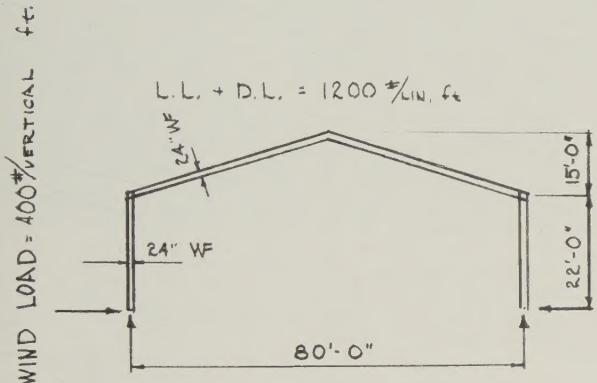


Fig. C-12

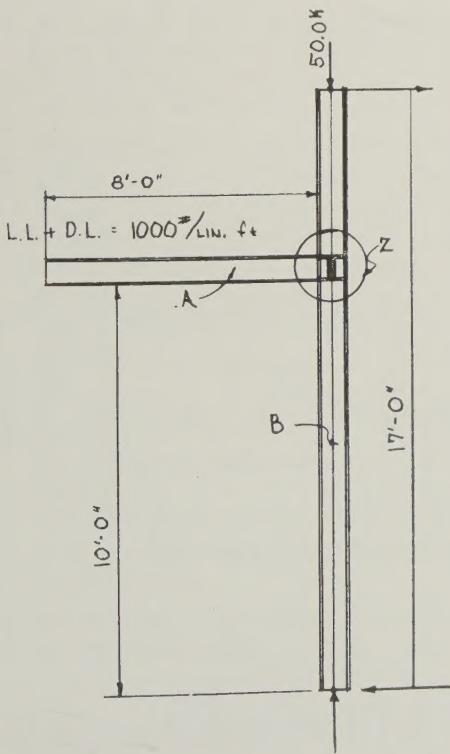


Fig. C-13

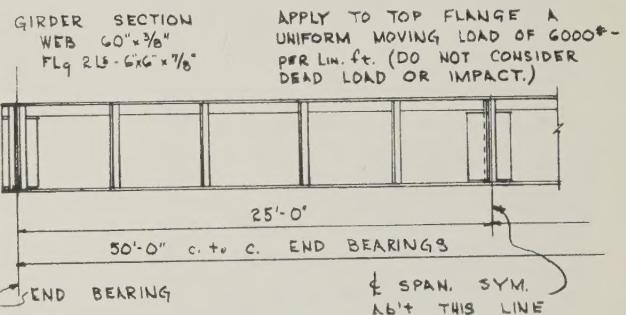


Fig. C-16

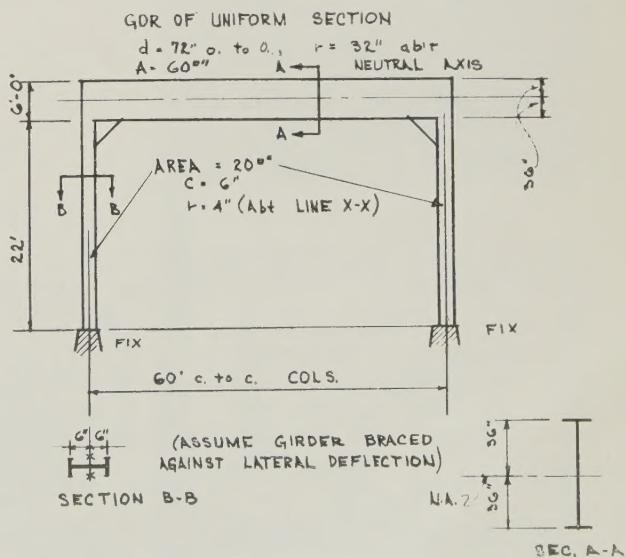


Fig. C-17

D1. Fig. D1 represents a rigid frame bridge pier, which by reason of the geometries of the structure is subject to an extreme unsymmetrical loading. Calculate the maximum soil pressure for the loading condition given in the figure.

D2. Fig. D2 represents a spillway for a power dam which has tainter gates for day to day control. The spillway is to be used to pass flood water.

Design the stop logs and indicate the depth of recess in the face of the pier. Use the following stresses:

1400 psi in bending

240 psi in compression transverse to grain

90 psi in horizontal shear

In your calculations use nominal (not dressed) size of timber.

D3. Fig. D3 represents a spillway controlled by needle beams. If timber cost \$300 per M Ft. B.M. and steel 15 cents per lb., which type of construction would be cheaper, that shown on Fig. D2 or Fig. D3.

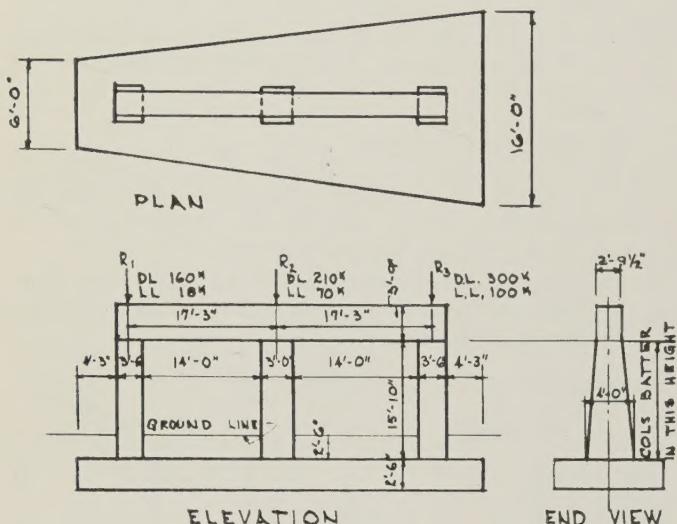


Fig. D-1

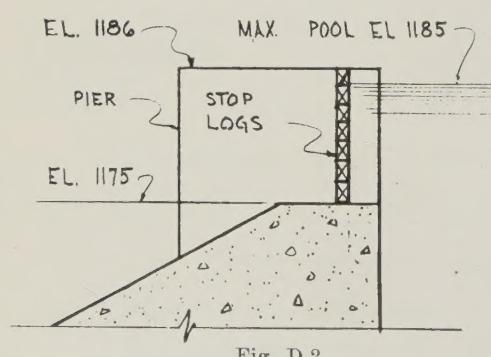


Fig. D-2

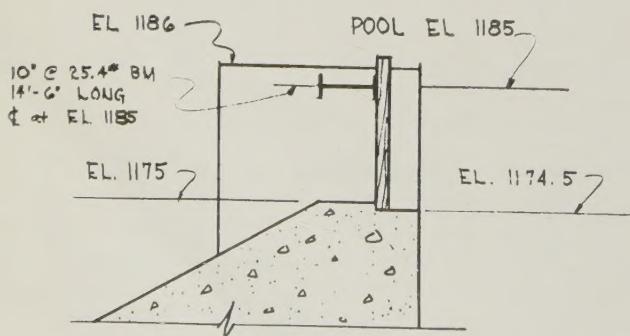


Fig. D-3

D4. Calculate the maximum pile pressure for the column footing shown on Fig. D4 and show in a sketch the reinforcing you would recommend be used.

The column load  $P$ —342 Kips

The lateral wind load  $W$  (at top of pier) is—32.5 Kips  
Design to be based on 3,000 psi concrete and structural grade steel. Use ACI code.

D5. The accompanying sketch shows in Fig. D5 a diagrammatic plan and cross-section of a proposed one story general purpose warehouse. The construction is to be of plank flooring supported on timber beams, which are in turn to be supported on the basement walls and timber girders along the center line. The girders to be supported on timber posts at intervals of 16'-0" as indicated. The floor is to be designed for a minimum live load of 150 lbs. per sq. ft. Use readily available structural timber and:

- Select safe plank flooring. (Laminated flooring may be used if preferred).
- Select a suitable beam spacing and design the beams.
- Design a typical floor girder and a typical post and show how the girders are to be supported on the posts.

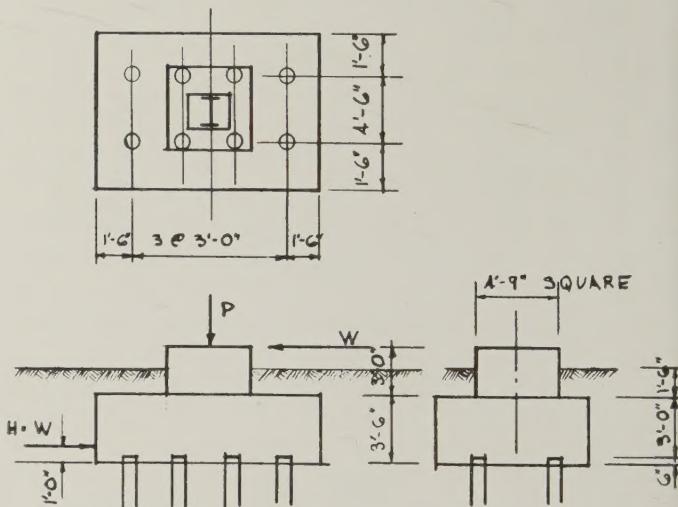


Fig. D-4

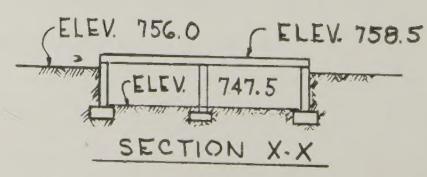
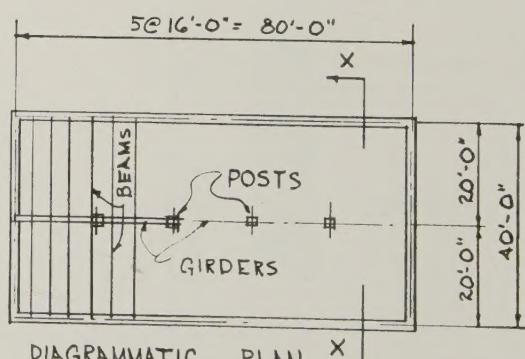


Fig. D-5

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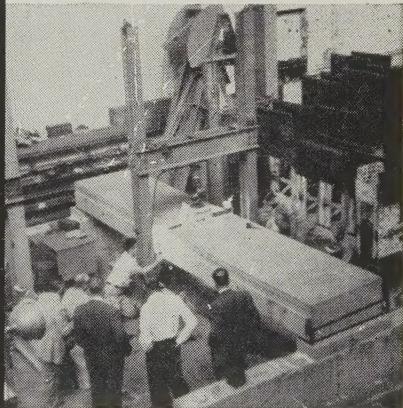
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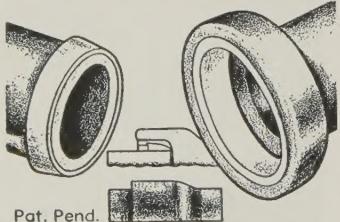
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Stomach ulcers are caused not so much by what you eat as by what's eating you.

Property is the fruit of labor; property is desirable; it is a positive good in the world. That some should be rich shows that others may become rich, and hence is just encouragement to industry and enterprise.

Let not him who is houseless pull down the house of another, but let him work diligently and build one for himself, thus by example assuring that his own shall be safe from violence when built.

—Abraham Lincoln

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